

OPERATIONS – MODULE 3b

NERC Reliability Functional Model – Describes proposed roles and responsibilities for Grid West and participants to meet the requirements of the NERC reliability functional model.

Real-Time Monitoring – Describes the proposed real-time monitoring process including the data needed to support both reliability and market functions.

Real-Time Balancing Service – Describes the operation of the balancing service used to obtain real-time Interconnected Operations Services for the CCA, while accounting for the nature and types of energy offers and selection of resources. It also describes the dispatch processes for resources selected by Grid West for the Real-Time Balancing Service including dispatch granularity, dispatch frequency, control signals process and routing, etc.

Emergency Operations – Describes the proposed emergency operations roles and responsibilities of Grid West for the GWMT as a Transmission Authority. The topics covered include emergency conditions, operating limits, NERC standards, the NWPP Energy Emergency Plan, and Grid West's operational responsibilities.

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1.0 EXECUTIVE SUMMARY

The NERC Reliability Functional Model¹ (the Functional Model) defines the functions that must be performed to ensure the reliability of the bulk power system. The model is being developed in order to accommodate the changing organizational structures that did not readily fit into existing definitions of control area or other organization types. The model provides a framework of functions with clearly identified responsibilities that can be used for Reliability Standards and Compliance Measures developed through the NERC standards approval process. Reliability Organizations, such as control areas, Regional Transmission Organizations, etc., may perform one or more functions described in the model. Every geographic (electrical) area must identify the organization responsible for performing each of the reliability functions in the model. Key reliability, market operations and system operations responsibilities identified in the model include:

- Operating Reliability (Interconnection Reliability Authority)
- Interchange (Interchange Coordinator)
- Balancing (Balancing Authority)
- Transmission Service (Transmission Service Provider)
- Planning Reliability (Interconnection Planning Coordinator)
- Resource Planning (Resource Planner)
- Market Operations (Market Operator or Resource Dispatcher)
- Transmission Operations (Transmission Authority)
- Transmission Ownership (Transmission Owner)
- Generator Operation (Generator Operator)
- Distribution (Distribution Provider)
- Generator Ownership (Generator Owner)
- Purchasing-Selling (Purchasing-Selling Entity)
- Load Serving (Load-Serving Entity)
- Compliance Monitoring (Compliance Monitor)

A fundamental principle of the Grid West development proposal is to improve the reliability of the bulk power system in the region. To achieve this goal, Grid West will perform a number of reliability, market operations and system operations functions. This paper uses the Functional Model as a framework for identifying

¹ The terminology used here is based on the recommendations of The Functional Model – Reliability Standards Coordination Task Force as explained in Section 3 of this document. The task force's recommended terminology changes are being used because they make it easier to identify the roles and responsibilities of Grid West.

the reliability, market operations and system operations functions that will be performed by Grid West.²

Highlights of this paper include:

- The Pacific Northwest Security Coordinator (PNSC) will serve as the Interconnection Reliability Authority for the Pacific Northwest.³
- Grid West will serve as the Transmission Authority for the entire Grid West Managed Transmission System (GWMT) with operational responsibilities delegated to the Transmission Owners.
- Grid West will serve as the Balancing Authority and the Interchange Coordinator for the Consolidated Control Area (CCA).
- Non-consolidating control areas will serve as the Balancing Authority and the Interchange Coordinator for their respective areas.
- Grid West will serve as the Transmission Service Provider for the GWMT for new services (Injection-Withdrawal Rights). Transmission owners will continue to honor their existing contracts and will serve as the Transmission Service Provider under the terms of those agreements.
- Grid West will serve as the Interconnection Planning Authority for the GWMT.
- Grid West will serve as the Market Operator for the Reconfiguration Services for the GWMT.
- Grid West will serve as the Market Operator for the Real-Time Balancing Service and Reserve Markets for the CCA.
- Transmission Owners, whether consolidating or not, will serve as the Transmission Operator⁴ for their respective facilities with some responsibilities delegated up to Grid West in its capacity as the Transmission Authority.
- Generation owning members, whether those that also own transmission facilities or IPPs, will serve as the Generator Operator for their respective facilities with operations coordinated through their host control area.

² Given the differently situated regulatory regime in Canada and British Columbia, in particular, the operating assumption is that the Grid West market design will be mirrored in British Columbia, to the extent possible within that regulatory regime. Details regarding the market design in British Columbia are anticipated to be completed as part of detailed design phase of this effort.

³ The exact nature of the relationship between the PNSC and Grid West needs to be defined further particularly with regard to governance, independence and duplication of effort. However, this objective is outside the scope of the TSLG.

⁴ A Transmission Operator separate from the Transmission Authority is not identified in the draft Functional Model; however, for our purpose it is useful to also identify Transmission Operator function so that the division of duties between the owners and Grid West can be more clearly described.

2.0 PURPOSE

This paper describes the reliability, market operations and system operations responsibilities of Grid West in terms of the Functional Model. The paper provides an overview of Version 2 of the model, together with the changes recommended by The Functional Model – Reliability Standards Coordination Task Force, and uses it as a framework for describing the functions that Grid West will perform.

3.0 BACKGROUND

3.1 NERC Reliability Functional Model

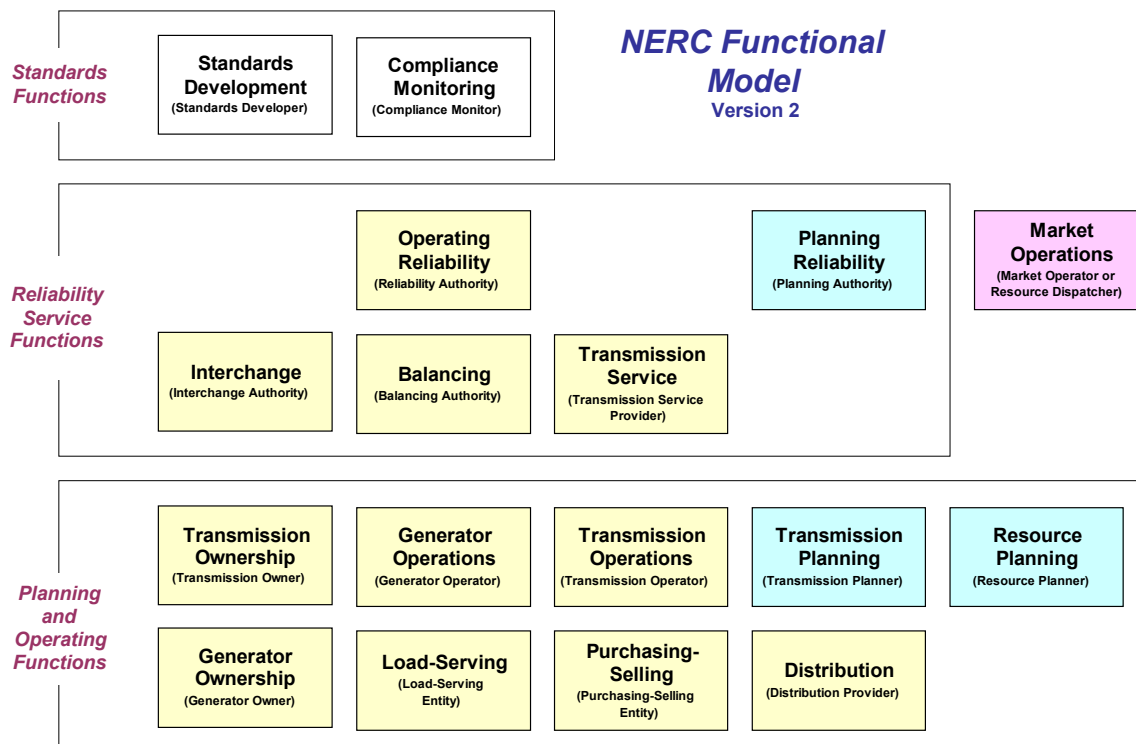
The Functional Model is being developed, in part, to define the sets of functions that must be performed to ensure the reliability of the bulk power system. The model is not a standard, and does not incorporate any compliance requirements. However, it is being developed as the framework for the Reliability Standards being developed separately by other NERC initiatives. The model identifies the tasks being performed today for electric system reliability so that reliability organizations such as Control Areas, Regional Transmission Organizations, Independent System Operators and others can more easily and clearly identify the reliability functions they provide. These functions are defined in general terms, and the relationships between the entities performing the individual tasks within each function are defined at a high level. The model leaves it up to the individual organizations - whether traditional vertically-integrated control areas, regional transmission operators, independent system operators, etc. – to decide how to implement and which entities undertake the different responsibilities.

Version 2 of the Functional Model is illustrated in the diagram below⁵. As seen in the diagram, the functions are grouped into Standard Functions, Reliability Service Functions and Planning and Operating Functions.

⁵ Source: NERC Reliability Functional Model Version 2

NERC Reliability Functional Model

Figure 3.1 NERC Reliability Functional Model



The key reliability responsibilities identified in this version of the model are:

- **Operating Reliability (Reliability Authority):** Ensures the real-time operating reliability of the interconnected bulk electric transmission systems within a Reliability Authority Area.
- **Interchange (Interchange Authority):** Authorizes implementation of valid and balanced interchange schedules between Balancing Authority Areas, and ensures interchange transactions are properly identified for reliability assessment purposes.
- **Balancing (Balancing Authority):** Integrates resource plans ahead of time, and maintains load-interchange-generation balance within a Balancing Authority Area and supports Interconnection frequency in real time
- **Transmission Service (Transmission Service Provider):** Administers the transmission tariff. Provides transmission services to qualified market participants under applicable transmission service agreements (for example, the pro forma tariff).

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- Planning Reliability (Planning Authority): Ensures a long-term (generally one year and beyond) plan is available for adequate resources and transmission within a Planning Authority Area. It integrates and assesses the plans from the Transmission Planners and Resource Planners within the Planning Authority Area to ensure those plans meet the reliability standards, and develops and recommends solutions to plans that do not meet those standards.

Other functions identified in the model relevant to the discussion presented in this paper include:

- Market Operations (Market Operator or Resource Dispatcher): Integrates energy, capacity, balancing and transmission resources to achieve an economic, reliability-constrained dispatch of resources. The dispatch may be either cost-based or bid-based.
- Transmission Operations (Transmission Operator): Operates or directs the operations of the transmission facilities.
- Generator Operations (Generator Operator): Operates generating unit(s) and performs the functions of supplying energy and Interconnected Operations Services.

Version 2 of the Functional Model was published in March 2004 and an extensive review period was conducted. Comments from the review period reflected among other things confusion regarding how some of the functions are implemented in practice in different organizations. They also reflected concerns regarding how to clearly delineate the boundaries between different functions and organizations so as to ensure that all the functions are properly covered.

Parallel to the development of the Functional Model, NERC developed and approved Version 0 of the Reliability Standards in early 2005 and they became effective April 1st, 2005. These standards are based on the Functional Model and include a number of the same functions described in it, e.g., Reliability Authority (Coordinator), Balancing Authority, Transmission Operator. During the development of these standards and the initial registration of the responsible entities, a number of issues and concerns that had previously been raised regarding the Functional Model, were raised again. As a result, the Functional Model – Reliability Standards Coordination Task Force was created with the charter to resolve these issues. This task force has issued a report ⁶ with

⁶ “Recommendations to Facilitate Use of the Functional Model to Guide the Development and Application of Reliability Standards”

recommendations that greatly clarify/simplify the applicability of the Functional Model. In particular, the suggested recommendations make it easier to use the model as a framework for describing the functions that Grid West will perform. Recommendations in the report relevant to the use of the model in this paper can be summarized as follows:

- Titles of responsible operating entities described in the Functional Model should be revised to emphasize both the wide-area role of the reliability authority and the authority of the transmission operator for reliability within its responsibility area. For example, the Reliability Authority should be the “Interconnection Reliability Authority” and the Transmission Operator should be the “Transmission Authority”.
- The Interconnection Reliability Authority definition, tasks and interrelationships in the Functional Model should be revised to focus on interconnection reliability and coordination of reliability among its transmission authorities.
- The Transmission Authority definition, tasks and interrelationships in the Functional Model should be revised to strengthen its authority and responsibilities to manage reliability within its area, subject to oversight by the Interconnection Reliability Authority looking at interconnection-related issues.
- The Planning Authority in the Functional Model should be named the “Interconnection Planning Coordinator.” The definition, tasks and interrelationships of the Interconnection Planning Coordinator, Transmission Planner, Resource Planner and Transmission Owner should be modified as necessary to recognize that Transmission Planners, Resource Planners and Transmission Owners have certain authorities in the planning process. The Interconnection Planning Coordinator description should be revised to emphasize the wide-area oversight, coordination and integration of transmission and resource plans across systems.
- The Interchange Authority should remain in the Functional Model but should be renamed the “Interchange Coordinator.” The Interchange Coordinator should be implemented in stages as driven by reliability need or business justification. The Interchange Coordinator definition, tasks and interrelationships should be modified to allow more flexibility and should be less prescriptive of a particular business model.

These suggested changes, as well as those suggested for the definition and tasks of the affected functions, have been incorporated into this paper.

4.0 GRID WEST'S RELIABILITY AND MARKET FUNCTIONS

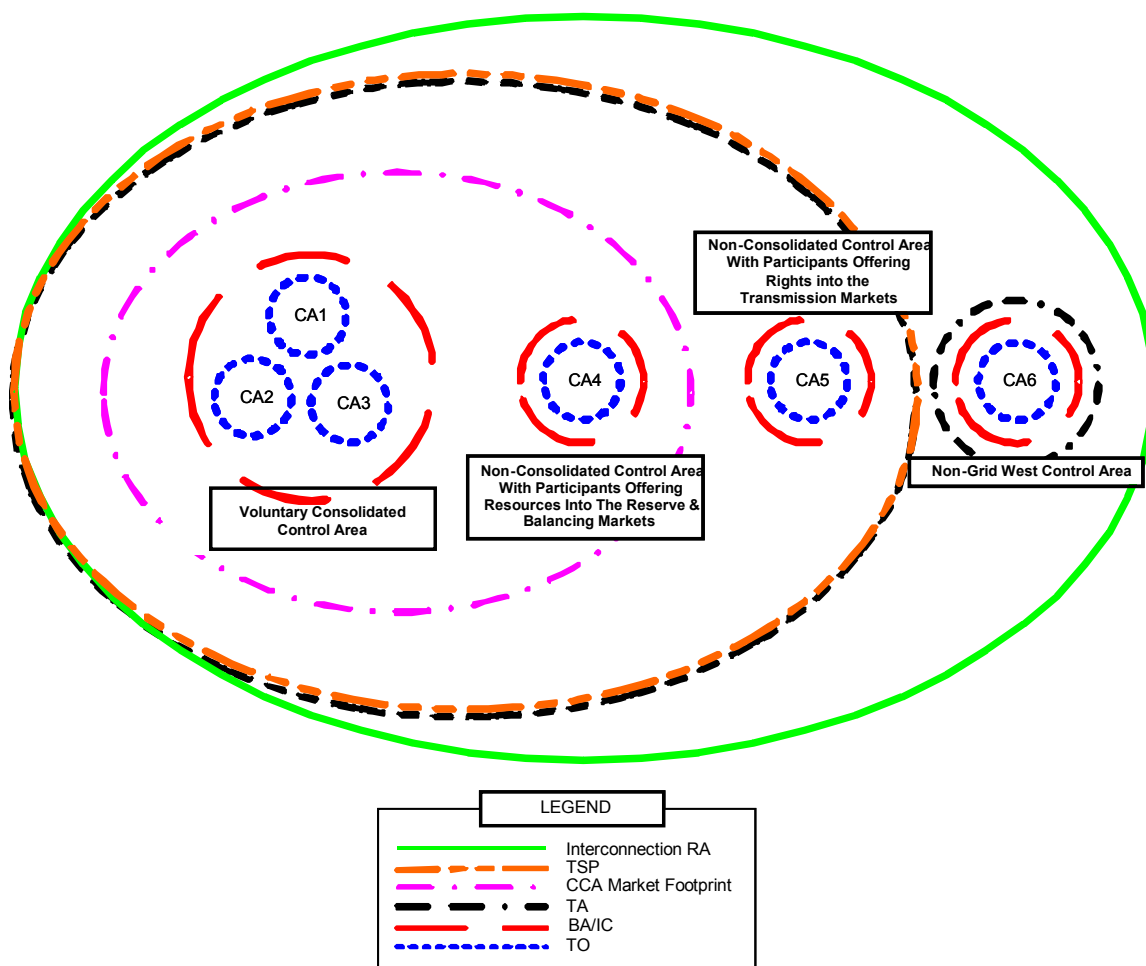
Grid West will be charged with transmission service provider responsibilities for the collective transmission facilities of its service area and the nondiscriminatory coordination of market transactions, system-wide transmission planning and network reliability (in coordination with the PNSC). Grid West will also operate a Consolidated Control Area (CCA) and administer a reserves market and real-time balancing service for those transmission-owning entities that choose to consolidate their control area operations.

Besides Grid West, there will be other entities responsible for reliability and system operations functions in the GWMT. These include:

- The Pacific Northwest Security Coordinator (PNSC)
- Transmission/Generation Operators/Owners that consolidate
- Transmission/Generation Operators/Owners that don't consolidate (including the control area responsibilities).
- Independent Power Producers

A high-level overview of the key reliability, system operations and market operations functions in the Grid West footprint is depicted in the diagram below.

Figure 4.1 Reliability, System Operations and Market Operations Responsibilities in Grid West



4.1 Interconnection Reliability Authority

The role and key tasks performed by the Interconnection Reliability Authority as defined in the Functional Model are summarized in the table below.

The PNSC will serve as the Interconnection Reliability Authority for the Pacific Northwest.

Currently, individual control areas throughout the region serve as the Reliability Authority for their own areas and the PNSC provides coordination

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among the areas. This role is very similar to the Interconnection Reliability Authority role that the PNSC will serve under the new reliability standards.

Table 4.1 Interconnection Reliability Authority Role and Tasks

Function	Interconnection Reliability Authority
Role	Ensures the operating reliability of the interconnected bulk electric transmission systems within an Interconnection Reliability Authority Area and the Interconnection. Has the responsibility and authority to direct and coordinate all operating reliability functions within its area to maintain the reliability of the Interconnection.
Key Tasks	<ul style="list-style-type: none"> • Maintain reliability of the Interconnection Reliability Authority Area in accordance with Reliability Standards • Monitor and record reliability-related parameters as required for reliability analysis of the Interconnection and the Interconnection Reliability Authority Area • Coordinate revisions to generation and transmission maintenance plans and direct revisions within the Interconnection Reliability Authority Area to maintain reliability • Develop and communicate Interconnection Reliability Operating Limits • Perform reliability analysis (actual-contingency and post-contingency) for the Interconnection Reliability Authority Area • Assess Interchange Schedules and direct actions to protect the reliability of the Interconnection and interconnected transmission systems within an Interconnection Reliability Authority Area • Identify, communicate, and direct actions to relieve reliability operating situations and reliability limit violations in the Interconnection Reliability Authority Area • Direct and coordinate implementation of emergency procedures • Direct and coordinate System Restoration • Coordinate operations with adjoining RAs • Evaluate and coordinate operating plans within the Interconnection Reliability Authority Area

4.2 Balancing Authority

The role and key tasks performed by the Balancing Authority as defined in the Functional Model are summarized in the table below.

The Balancing Authority responsibilities in the GWMT will be split amongst several entities as follows:

- Grid West will serve as the Balancing Authority for the CCA
- The non-CCA areas will serve as the Balancing Authority for their respective balancing areas.

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The Balancing Authority Area for Grid West will include the control area of all the transmission-owning entities that choose to consolidate their control area operations into the CCA. Initially, it is anticipated that three of the largest Grid West transmission owning members will be consolidating and an allowance will be made for others to consolidate or not as they choose. Key drivers for consolidation are improving the system reliability and operational efficiencies.

Currently, individual control areas throughout the region serve as the Balancing Authority for their own areas.

Table 4.2 Balancing Authority Role and Tasks

Function	Balancing Authority
Role	Integrates resource plans ahead of time, keeps actual interchange equal to its scheduled interchange and provides frequency bias obligation for its Balancing Authority in real time.
Key Tasks	<ul style="list-style-type: none"> • Must have control of any of the following combinations within a Balancing Authority Area: <ol style="list-style-type: none"> 1. Load and Generation (an isolated system) 2. Load and Scheduled Interchange 3. Generation and Scheduled Interchange 4. Generation, Load, and Scheduled Interchange • Calculate Area Control Error within the Balancing Authority Area • Review generation commitments, dispatch, and load forecasts • Formulate an operational plan (generation commitment, outages, etc) for reliability assessment • Approve Interchange Transactions from ramping ability perspective • Implement interchange schedules by entering those schedules into an energy management system for both AC system and DC ties • Provide frequency response • Monitor and report control performance and disturbance recovery • Provide balancing and energy accounting (including hourly checkout of Interchange Schedules and Actual Interchange), and administer Inadvertent energy paybacks • Determine needs for Interconnected Operations Services • Deploy Interconnected Operations Services • Implement emergency procedures

4.3 Interchange Coordinator

The role and key tasks performed by the Interchange Coordinator as defined in the Functional Model are summarized in the table below.

This function was not made part of the Version 0 Reliability Standards and all its tasks were merged into the Balancing Authority.

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Based on the Version 0 Reliability Standards, Grid West would serve as the Interchange Coordinator for the entire CCA as it also serves as the Balancing Authority. The assignment of these responsibilities may change as the definition of the roles and tasks of the function evolves further.

Table 4.3 Interchange Coordinator Role and Tasks

Function	Interchange Coordinator
Role	Receives approvals and communicates authorization to implement valid and balanced interchange schedules between Balancing Authority Areas, and ensures interchange transactions are properly identified for reliability assessment purposes.
Key Tasks	<ul style="list-style-type: none"> • Determine valid, balanced, Interchange Schedules (validation of sources and sinks, transmission arrangements, interconnected operations services, etc.) • Verify ramping capability of the source and sink Balancing Authority Areas for requested Interchange Schedules • Collect and disseminate Interchange Transaction approvals, changes and denials • Authorize implementation of Interchange Transactions over both AC and DC interfaces • Enter Interchange Transaction information into Reliability Assessment Systems (e.g., the Interchange Distribution Calculator in the Eastern Interconnection) • Maintain record of individual Interchange Transactions

4.4 Transmission Service Provider

The role and key tasks performed by the Transmission Service Provider as defined in the Functional Model are summarized in the table below.

Grid West will serve as the Transmission Service Provider for the GWMT for new services (Injection-Withdrawal Rights). Transmission owning members, whether consolidating or not, will continue to honor their existing contracts and will serve as the Transmission Service Provider under the terms of those agreements. Grid West will provide some of the required tasks for these services on behalf of the transmission owning members.

Currently, individual Transmission Owners throughout the region serve as the Transmission Service Provider for their own facilities.

Table 4.4 Transmission Service Provider Role and Tasks

Function	Transmission Service Provider
Role	Administers the transmission tariff and provides transmission services to qualified market participants under applicable transmission service agreements (for example, the pro forma tariff).
Key Tasks	<ul style="list-style-type: none"> • Receive transmission service requests and process each request for service

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	<p>according to the requirements of the tariff</p> <ul style="list-style-type: none"> • Maintain commercial interface for receiving and confirming requests for transmission service according to the requirements of the tariff (e.g., OASIS) • Approve or deny transmission service requests • Approve Interchange Transactions from transmission service arrangement perspective • Determine and post available transfer capability (ATC) values • Allocate transmission losses (MWs or funds) among Balancing Authority Areas • Coordinate with Transmission Planner and Interconnection Planning Coordinator to develop plans to accommodate transmission service requests that cannot be accommodated with existing planned facilities
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4.5 Transmission Authority

The role and key tasks performed by the Transmission Authority as defined in the Functional Model are summarized in the table below.

Grid West will serve as the Transmission Authority for the entire GWMT. Transmission Owners will continue to have operational responsibilities for their facilities as directed by Grid West or per standing orders.

Currently, individual Transmission Owners throughout the region serve as the Transmission Authority for their own facilities.

Table 4.5 Transmission Authority Role and Tasks

Function	Transmission Authority
Role	Ensures the reliability of the bulk electric transmission system within a Transmission Authority Area. Has the responsibility and authority to direct and coordinate the operation of transmission facilities within its area to maintain the reliability of the bulk electric system.
Key Tasks	<ul style="list-style-type: none"> • Develop transmission operating and contingency plans and operate the system to ensure the reliability of the area in accordance with Reliability Standards • Determine and communicate System Operating Limits • Monitor and perform reliability analysis of the Transmission Authority Area • Implement detailed transmission maintenance schedules (dates and times) provided by the Transmission Owner • Adjust dc ties and phase shifters within the transmission area for those Interchange Transactions that include these facilities in the transmission path • Deploys reactive resources to maintain voltages within defined voltage limits • Provide telemetry of transmission system information in real time and historical operating information as required • Coordinate operations plans, reliability analysis, and operations with the Interconnection Reliability Authority, Balancing Authority, and other Transmission Authorities

	<ul style="list-style-type: none"> • Implement reliability measures as directed by the Interconnection Reliability Authority • Requests the Balancing Authority to adjust generation dispatch to relieve System Operating Limit violations • Approve or deny Interchange Schedules from a reliability perspective • Develop and implement emergency procedures • Develop and implement System Restoration Plan
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4.6 Interconnection Planning Coordinator

The role and key tasks performed by the Interconnection Planning Coordinator as defined in the Functional Model are summarized in the table below.

Grid West will be responsible for transmission planning for the GWMT and will work with WECC, as appropriate.

Table 4.6 Interconnection Planning Coordinator Role and Tasks

Function	Interconnection Planning Coordinator
Role	Ensures a plan generally one year and beyond is available for adequate resources and transmission within an Interconnection Planning Coordinator Area. It integrates and assesses the plans from the Transmission Planners and Resource Planners within the Interconnection Planning Coordinator Area to ensure those plans meet the reliability standards, and develops corrective actions for plans that do not meet those standards.
Key Tasks	<ul style="list-style-type: none"> • Develop and maintain transmission and resource (demand and capacity) system models to evaluate transmission system performance and resource adequacy • Maintain and develop methodologies and tools for the analysis and simulation of the transmission systems in the assessment and development of transmission expansion plans and the analysis and development of resource adequacy plans • Define, collect or develop and share information required for planning purposes, including: <ol style="list-style-type: none"> 1. Transmission facility characteristics and ratings, 2. Demand and energy customer forecasts, capacity resources, and demand response programs, 3. Generator unit performance characteristics and capabilities, and 4. Long-term capacity purchases and sales. • Evaluate plans for customer requests for transmission service: <ol style="list-style-type: none"> 1. Evaluate responses to long-term (generally one year and beyond) transmission service requests. 2. Review transmission facility plans required for integrating new (end-use customer, generation, and transmission) facilities into the interconnected bulk electric systems. • Review and determine TTC, IROL and SOL values (generally one year and beyond) as appropriate • Assess, develop, document and report on resource and transmission

	<p>expansion plans:</p> <ol style="list-style-type: none"> 1. Integrate and verify that the respective plans for the Interconnection Planning Coordinator Area meet reliability standards. 2. Identify and report on potential transmission system and resource adequacy deficiencies, and provide alternate plans that mitigate these deficiencies. <ul style="list-style-type: none"> • Monitor transmission expansion plan and resource plan implementation • Coordinate projects requiring transmission outages that can impact reliability and firm transactions • Evaluate the impact of revised transmission and generator in-service dates on resource and transmission adequacy • Work with adjoining Interconnection Planning Coordinators so that system models and resource and transmission expansion plans take into account modifications made to networks in adjacent Interconnection Planning Coordinator Areas
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4.7 Market Operator

The Market Operator administers markets to provide capacity, energy, balancing resources and other Ancillary Services subject to system requirements and constraints. This function is not really a function of the Functional Model but is included in it to facilitate describing the interaction with other functions in the model.

Grid West will serve as the Market Operator for the following markets and services:

- Transmission Rights Reconfiguration Service: Will facilitate the acquisition and trading of transmission rights by Grid West participants. This service will be facilitated for the GWMT.
- Reserves: Will facilitate the day-ahead procurement of reserves necessary to meet the applicable Western Electricity Coordinating Council (WECC) Minimum Operating Reliability Criteria (MORC) and the North American Reliability Council (NERC) Operating Policy Standards related to regulation performance and operating reserves and other reliability standards. This market will be facilitated for the CCA but non-CCA members can also offer to provide services.
- Real-Time Balancing Service: Will facilitate the real-time procurement of balancing energy on the basis of economics and reliability in order to match system load with online generation while observing resource and transmission constraints. This service will be facilitated for the CCA but non-CCA members can also offer to provide services.

4.8 Generator Operator

The role and key tasks performed by the Generator Operator as defined in the Functional Model are summarized in the table below.

Generation owning members, whether those that also own transmission facilities or IPPs, will serve as the Generator Operator for their respective facilities with operations coordinated through the control area where the facilities are located.

Table 4.7 Generator Operator Role and Tasks

Function	Generator Operator
Role	Operates generating unit(s) and performs the functions of supplying energy and Interconnected Operations Services including non-market IOS (e.g., reactive power supply, black-start capability).
Key Tasks	<ul style="list-style-type: none"> • Operate generators to provide energy or Interconnected Operations Services (or both) per contracts or arrangements • Formulate daily generation plan • Report operating and availability status of units and related equipment, such as automatic voltage regulators • Develop annual maintenance plan for generating units and perform the day-to-day generator maintenance

5.0 ROLES AND RESPONSIBILITIES

Roles and responsibilities of Grid West and its members with respect to key reliability, market operations and system operations functions identified by the NERC Reliability Functional Model are summarized in the table below.

Table 5.1 NERC Reliability Functional Model Roles and Responsibilities in Grid West

Function	Grid West	Member: CCA	Member: Non-CCA	IPPs	PNSC
Interconnection Reliability Authority	None				Pacific North West including GWMT
Balancing Authority	CCA		Own Balancing Authority Area		
Interchange Coordinator	CCA (initially)		Own Balancing Authority Area		
Transmission Service Provider	GWMT	(for pre-existing contracts)	(for pre-existing contracts)		

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Transmission Authority	GWMT	Operational responsibilities for own facilities as directed by GW or per standing orders	Operational responsibilities for own facilities as directed by GW or per standing orders	Operational responsibilities for own facilities as directed by GW or per standing orders	
Planning Reliability Authority	GWMT				
Market Operator	Reserve Market and RTBS for CCA, RCS for GWMT				
Generator Operator		Own facilities	Own facilities	Own facilities	

6.0 MARKET BENCHMARKS

All RTOs/ISOs in North America perform some of the NERC Reliability Functional Model responsibilities. The table below compares the assignment of these responsibilities in the Grid West with the assignment in PJM, ERCOT and MISO.

Table 6.1 Market Benchmarks

Function	Grid West	PJM	ERCOT	MISO
Interconnection Reliability Authority	PNSC for Pacific Northwest including GWMT	Entire footprint	Entire footprint	Entire footprint
Balancing Authority	CCA	Entire footprint	Entire footprint	Various BAs within footprint
Interchange Coordinator	CCA (initially)	Entire footprint	Not really an IA. Few transactions with external connections.	Not really an IA. NERC scheduling for portions of the entire footprint located within BAs covered by the EMT
Transmission Service Provider	GWMT	Entire footprint	Various TSPs within the footprint	Portions of the entire footprint located within BAs covered by the EMT
Transmission Authority	GWMT with operational	Owners as directed by PJM	Owners as directed and	Owners as directed by

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	responsibilities delegated to TOS		coordinated by TSPs and ERCOT	MISO
Interconnection Planning Coordinator	GWMT	Entire footprint	Entire footprint	Entire footprint
Market Operator	Reserve Market and RTBS for CCA, RCS for GWMT	Entire footprint	Entire footprint	Portions of the entire footprint located within BAs covered by the EMT
Generator Operator	Owners as directed by corresponding BAs	Owners as directed by PJM	Owners as directed by QSE	Owners as directed by corresponding BAs

7.0 TECHNOLOGY SOLUTIONS

The NERC Reliability Functional Model responsibilities that the Grid West will perform will require the following applications/systems:

- SCADA including telemetry from RTUs and/or ICCP
- Data acquisition (SCADA) including telemetry from RTUs and/or ICCP
- Real-Time Calculations
- Alarming
- Reserve Computation
- Automatic Generation Control (AGC)
- Outage Scheduling
- Advance Power System Applications; State Estimator, Contingency Analysis, Power Flow, etc.
- Transaction Scheduling System
- OASIS and E-tagging tools
- Transmission Rights Reconfiguration Service tools
- Reserve Markets and Real-Time Balancing Service tools
- Voice communications between Grid West and member entities control centers

8.0 COST DRIVERS

The Grid West functional responsibilities described in this paper encompass a significant portion of the overall operational responsibilities of Grid West. The primary cost drivers for the implementation of these functional responsibilities include infrastructure, personnel and system requirements.

9.0 DESIGN ISSUES FOR CONSIDERATION IN NEXT DEVELOPMENT LAYER

The next layer of design should include a review of the following design issues:

- The exact nature of the relationship between the PNSC and Grid West needs to be defined further, particularly with regard to governance, independence and duplication of effort.

1.0 EXECUTIVE SUMMARY

Grid West will perform several of the roles defined within the NERC Reliability Functional Model for both the Consolidated Control Area (CCA) and for the Grid West Managed Transmission System (GWMT). Examples include:

- Reliability functions
- System operation functions
- Market operations functions

To perform these roles, Grid West must have the ability to monitor, analyze and process relevant system conditions and data in real time. A number of systems and applications will be implemented to provide Grid West with this capability. These will include a real-time data acquisition function to enable the acquisition of real-time measurements, applications to process and/or calculate other relevant quantities (e.g., alarming, real-time calculations, reserve calculation, AGC), applications to analyze system conditions (State Estimator, Contingency Analysis, etc.) and market applications. This paper identifies the relevant system conditions and data for each Grid West functional responsibility, as well as the system and/or application associated with each system condition and data item.¹

Highlights of this paper include:

- Grid West will monitor a number of system conditions and data as part of its reliability, systems operations and market operations functional responsibilities.
- Grid West will implement a variety of systems and applications to provide the required real-time monitoring functionality. These will include:
 - a. Supervisory Control and Data Acquisition (SCADA)
 - b. Generation and scheduling functions: Automatic Generation Control (AGC), Reserve Monitoring, Load Forecasting, Interchange Scheduling, Energy Accounting
 - c. Advanced power system applications: Outage Scheduling, Network Status Processor, State Estimator, Contingency Analysis, Post-Disturbance Recording
 - d. Market functions: OASIS, Tag applications, Market Portal, Real-time Balancing Service

¹ Given the differently situated regulatory regime in Canada and British Columbia, in particular, the operating assumption is that the Grid West market design will be mirrored in British Columbia, to the extent possible within that regulatory regime. Details regarding the market design in British Columbia are anticipated to be completed as part of the detailed design phase of this effort.

- e. Communications Functions: Inter Control Center Communications Protocol (ICCP) for real-time data exchange and Electric Industry Data Exchange (EIDE) for non real-time data exchange.
- Grid West will acquire real-time measurements from member control centers and external control centers via ICCP and will acquire non real-time data (such as meter data, schedule data, lake elevations, etc.) via EIDE. Redundancy for critical measurements will also have to be considered.

2.0 PURPOSE

This paper identifies the relevant system conditions and data that Grid West will monitor, process and analyze in real time in support of its reliability, system operations and market operations functions. The paper also identifies systems and applications associated with each system condition and data item.

3.0 BACKGROUND

3.1 Grid West Reliability and Market Functions

Grid West's functional responsibilities for reliability, system operations and market operations of the CCA and for the GWMT are summarized in the table below. Performance of some of these functions requires real-time monitoring capabilities that are described in the sections that follow.

Figure 3.1 Grid West responsibilities for the CCA and the GWMT

Function	CCA	GWMT
Transmission Authority		<input checked="" type="checkbox"/>
Balancing Authority	<input checked="" type="checkbox"/>	
Interchange Coordinator	<input checked="" type="checkbox"/>	
Transmission Service Provider		<input checked="" type="checkbox"/>
Interconnection Planning Coordinator		<input checked="" type="checkbox"/>
Market Operator	<input checked="" type="checkbox"/>	

4.0 GRID WEST'S REAL-TIME MONITORING REQUIREMENTS

4.1 Transmission Authority Function

As the Transmission Authority for the GWMT, Grid West will ensure the real-time operating reliability of the bulk electric transmission systems of the GWMT. The table below summarizes the key system conditions and data items that need to be monitored as part of this function. The system and/or applications associated with each item are also identified.

Table 4.1 Transmission Authority Function Monitoring Conditions

System Condition/Data Item	System/Application
Thermal facilities – transmission paths, transmission lines, transformers, Phase Angle Regulators (PARs), actual flows and post-contingency flows	<ul style="list-style-type: none"> • SCADA • State Estimator • Contingency Analysis
Voltage – actual and post-contingency	<ul style="list-style-type: none"> • SCADA • State Estimator • Contingency Analysis
Generation facilities – status, active and reactive outputs, max and min response capabilities	<ul style="list-style-type: none"> • SCADA • AGC
Active and reactive reserves – requirements, actual amount and location	<ul style="list-style-type: none"> • SCADA • Reserve Calculation
ACE, system frequency, total system load and generation, actual interchange, scheduled interchange, short-term load forecast	<ul style="list-style-type: none"> • SCADA • Real-Time Calculations • AGC • Interchange Scheduling • Load Forecaster
Neighboring systems: major facilities, ACE, reserves	<ul style="list-style-type: none"> • SCADA • Real-Time Calculations
Status/outage of generator and transmission facilities, notification of modifications to network topology and ICCP data points	<ul style="list-style-type: none"> • SCADA • Network Status Processor • Outage Scheduling
Status of RAS and system conditions requiring RAS operations	<ul style="list-style-type: none"> • SCADA • RAS Application
System disturbances	<ul style="list-style-type: none"> • SCADA
Communication Systems	<ul style="list-style-type: none"> • SCADA • HW/SW Monitoring tools

4.2 Balancing Authority Function

As the Balancing Authority for the CCA, Grid West will integrate resource plans ahead of time, keep actual interchange equal to its scheduled interchange and provide frequency bias obligation for the CCA in real time.

The table below summarizes the key system conditions and data items needed as part of this function. The monitoring processes associated with each item are also identified.

Table 4.2 Balancing Authority Function Monitoring Conditions

System Condition/Data Item	System/Application
ACE, system load, total generation and total interchange	<ul style="list-style-type: none"> • SCADA • Real-Time Calculations • AGC
Transmission facilities: control area interchange points (tie-lines) flows	<ul style="list-style-type: none"> • SCADA • AGC
Short-term load forecast	<ul style="list-style-type: none"> • Load Forecaster
Net scheduled interchange amount including anticipated changes and ramps	<ul style="list-style-type: none"> • SCADA • Reserve Calculation
Generation facilities – status, MW outputs, limits, response capability, regulation reserve awards/designations	<ul style="list-style-type: none"> • SCADA • AGC • Reserve Calculation
Reserves: actual reserves; regulation, spin and non-spin	<ul style="list-style-type: none"> • SCADA • Reserve Calculation
Energy Accounting, Actual Interchange calculation, Inadvertent Interchange and time error	<ul style="list-style-type: none"> • AGC

4.3 Interchange Coordinator Function

As the Interchange Authority for the CCA, Grid West will receive approvals and communicate authorization to implement valid and balanced interchange schedules, and will ensure interchange transactions are properly identified for reliability assessment purposes. The table below summarizes the key system conditions and data items needed as part of this function. The monitoring processes associated with each item are also identified.

Table 4.3 Interchange Coordinator Function Monitoring Conditions

System Condition/Data Item	System/Application
Interchange transactions: start and end times, ramps, amounts, point of delivery/point of receipt, transmission rights, etc	<ul style="list-style-type: none"> • Interchange Scheduling • OASIS
E-tag information: transaction data, approvals, denials, etc.	<ul style="list-style-type: none"> • Tag Applications
Ramping capability of source/sink control areas	<ul style="list-style-type: none"> • SCADA • Real-Time Calculations • AGC
Net scheduled interchange amount including anticipated changes and ramps	<ul style="list-style-type: none"> • Interchange Scheduling • OASIS

4.4 Transmission Service Provider

As the Transmission Service Provider for the GWMT, Grid West will administer the transmission tariff and provide transmission services to qualified market participants, and will direct the operations of the transmission facilities. The table below summarizes the key system conditions and data items needed as part of these functions. The monitoring processes associated with each item are also identified.

Table 4.4 Transmission Service Provider Function Monitoring Conditions

System Condition/Data Item	System/Application
Transmission Service Requests	<ul style="list-style-type: none"> OASIS
AFC	<ul style="list-style-type: none"> AFC Calculation
Thermal facilities – transmission paths, transmission lines, transformers, PARs, actual flows and post-contingency flows	<ul style="list-style-type: none"> SCADA State Estimator Contingency Analysis
Voltage – actual and post-contingency	<ul style="list-style-type: none"> SCADA State Estimator Contingency Analysis
Status/outage/maintenance plans of transmission facilities	<ul style="list-style-type: none"> SCADA Network Status Processor Outage Scheduling
Interchange transactions: start and end times, ramps, amounts, point of delivery/point of receipt, transmission rights, etc	<ul style="list-style-type: none"> Interchange Scheduling OASIS

4.5 Market Operator Function

As the Market Operator, Grid West will administer a Reserve Market and a Real-time Balancing Service for the CCA. The table below summarizes the key system conditions and data items needed as part of these functions. The monitoring processes associated with each item are also identified.

Table 4.5 Market Operator Function Monitoring Conditions

System Condition/Data Item	System/Application
Generation facilities – status, MW outputs, limits, response capability, regulation reserve awards/designations	<ul style="list-style-type: none"> SCADA AGC Reserve Calculation

Reserves: actual reserves; regulation, spin and non-spin	<ul style="list-style-type: none"> • SCADA • Reserve Calculation
Reserve Requirements	<ul style="list-style-type: none"> • Reserve Calculation
Reserve Offers, Inc/Dec Bids	<ul style="list-style-type: none"> • Market Portal
Balanced Schedules	<ul style="list-style-type: none"> • Market Portal
Load Forecast	<ul style="list-style-type: none"> • Load Forecaster
System solution, constraints	<ul style="list-style-type: none"> • SCADA • State Estimator • Contingency Analysis
Status/outage/maintenance plans of transmission facilities	<ul style="list-style-type: none"> • SCADA • Network Status Processor • Outage Scheduling

4.6 Real-Time Measurements

A critical component of Grid West's real-time monitoring requirements is the acquisition of real-time measurements. It is anticipated that Grid West will obtain real-time measurements from existing member control centers and external control centers via data exchange mechanisms (e.g., ICCP). This will eliminate the need to implement dedicated remote terminal units (RTUs) and the associated communications infrastructure and will help minimize implementation costs. However, the implementation of redundancy for all measurements critical to the Reliability Authority and Balancing Authority (e.g., generator MW outputs, tie-line flows, transmission path flows, critical system voltages) will have to be considered. In many cases, existing control areas have implemented redundancy throughout their systems. Using redundant ICCP links, routers and multiple WECC Operational Network (WON) physical paths would provide redundancy in these cases

5.0 ROLES AND RESPONSIBILITIES

Grid West will implement, operate and maintain all systems and applications described in this paper.

Transmission owning members will provide real-time measurements to Grid West via data exchange mechanisms. This will include all data currently available at the existing control centers.

Transmission owning members will support the creation and maintenance of a network model representation of their facilities to be incorporated in the model

used by Grid West. This model together with the available measurement set will be key to the operation of the State Estimator and Contingency Analysis functions.

6.0 MARKET BENCHMARKS

All existing RTOs/ISOs have implemented and are operating systems and applications as the ones described here. There will probably be functional differences between some of the RTOs/ISOs and Grid West, but these will be mostly due to differences in market design and operational practices.

7.0 TECHNOLOGY SOLUTIONS

A number of systems and applications will be required to support the Grid West real-time monitoring requirements. These are briefly described below in terms of the monitoring function that they provide:

- Supervisory Control and Data Acquisition (SCADA): Enables acquisition of all required real-time measurements (e.g., line flows, voltages, breaker/switch statuses). Data will be acquired from either remote terminal units (RTUs) or from other control centers via data exchange mechanisms (e.g., IEC 61850). Also processes all incoming real-time measurements and calculated quantities to identify those exceeding pre-defined limits (analog quantities) or in an abnormal state (digital statuses). Alarms for each of the identified items are generated to allow system operators to quickly identify issues.
- Real-Time Calculations (typically part of SCADA): Enables calculations of other quantities of interest based on incoming real-time measurements. These are simple calculations such as additions, subtraction, AND, OR, etc.
- Reserve Monitoring: Calculates actual reserves based on current generator conditions (statuses, actual outputs, etc.), operating characteristics (limits, response rates, etc.) and reserve awards/designations.
- Automatic Generation Control (AGC): Calculates ACE and over/under generation conditions. Will also calculate total system load and generations and actual interchange.

- **Energy Accounting:** Necessary to calculate Inadvertent Interchange which is an ACE component. Calculates Actual Interchange and Inadvertent Interchange and cumulative Inadvertent for light and heavy load hours
- **Interchange Scheduling:** Keeps track of interchange transactions. Calculates net scheduled interchange including anticipated changes and ramps.
- **Outage Scheduling:** Keeps track of planned and forced outages.
- **Network Status Processor:** Calculates equipment connectivity statuses.
- **State Estimator:** Uses a network model representation of the system together with available measurements (breaker/switch statuses and analog measurements) to develop a complete system solution that can be used by other power system analysis applications. Also performs bad data detection to identify measurements in error.
- **Contingency Analysis:** Uses the current State Estimator solution to analyze the impact of single and multiple contingencies in real-time. Provides post-contingency flows and voltages for monitored thermal facilities and buses.
- **Tag applications:** Facilitates creation and processing of e-tags. Processes tag approvals and rejections.
- **OASIS (transmission service information system):** Use to post available transmission rights and process transmission service requests.
- **AFC Calculation:** Calculates AFC based on approved rights.
- **Communications:** ICCP used for real-time data exchange over the WON. EIDE used for non real-time data exchange over either the WON or the Internet.

8.0 COST DRIVERS

The primary cost drivers for the implementation of the real-time monitoring requirements described in this paper are infrastructure, personnel and systems and applications requirements.

Other implementation-related cost drivers include:

- Redundancy of critical real-time measurements
- Network model development

9.0 DESIGN ISSUES FOR CONSIDERATION IN NEXT DEVELOPMENT LAYER

The next layer of design should include a review of the following design issues:

- *Redundancy of real-time measurements* - Redundancy for all measurements critical to the Reliability Authority and Balancing Authority (e.g., generator MW outputs, tie-line flows, transmission path flows, critical system voltages) should be implemented.

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1.0 EXECUTIVE SUMMARY

This paper describes the Grid West Real-Time¹ Balancing Service (RBS) that will be used to acquire Interconnected Operations Services² (IOS) to provide balancing service for the Consolidated Control Area (CCA), while accounting for the nature and types of bids and offers, and selection of resources. It also describes the dispatch process for resources selected by Grid West for the balancing service, including dispatch granularity, dispatch frequency, control signals process and routing, etc.³

Highlights of this paper include:

- Grid West will administer the RBS for the CCA
- Transmission Customers are required to submit balanced energy schedules before entering real-time operations
- Imbalance requirements are expected to be a small percentage of the total energy demand
- Parties within the CCA may submit INC offers and/or DEC bids into the RBS
- Parties outside the CCA can also submit INC offers and/or DEC bids to provide services. These will be considered as long as they serve to meet the requirements of the CCA.
- Grid West will not require participants to obtain transmission rights to participate in the RBS
- Balancing service will support generation/load following, manage congestion, and promote economic efficiency within the CCA
- Locational pricing will be used; however, the consolidating parties will determine how suppliers and loads will be charged (e.g., locational imbalance price might be used to pay generators while zonal prices may be used to charge loads)
- Dispatch instructions, in the form of generation basepoints and dynamic schedules, will be routed through the Grid West control system to the

¹ Real-Time is defined as the time period between 30 minutes prior to the Operating Hour to the close of the hour.

² IOS are used to maintain generation and demand balance (i.e., regulation, load following and contingency reserve), to maintain a secure transmission network (i.e., reactive power supply and frequency response) and for emergency preparedness and restoration (i.e., black-start capability). The purpose of RBS is to maintain generation and demand balance.

³ Given the differently situated regulatory regime in Canada and British Columbia, in particular, the operating assumption is that the Grid West market design will be mirrored in British Columbia, to the extent possible within that regulatory regime. Details regarding the market design in British Columbia are anticipated to be completed as part of detailed design phase of this effort.

control systems of consolidating Transmission Owners (TOs) and participants outside the CCA

2.0 PURPOSE

The purpose of the RBS is to reliably match system supply and demand of the Grid West CCA. It will utilize available bids and offers to provide imbalance requirements economically while observing all system operating constraints. A secondary consideration of the RBS is enhancing economic efficiency through a full utilization of the transmission capability of the Grid West Managed Transmission System—which addresses one of the fundamental problems identified in the RRG Regional Proposal.

3.0 BACKGROUND

A majority of the CCA energy requirements are met through accepted balanced schedules. However, energy imbalances, i.e., differences between supply and demand - are inevitable during real-time operations. Imbalance energy can result from any of the following:

- Intra-hour load variations including load forecast errors and loss variations (Load Following)
- Generation deviation
- Transmission congestion
- Forced generation or transmission outages

Uncorrected, these deviations threaten the reliability of the system and must therefore be offset to maintain system/frequency balance. Currently, control areas apply financial consequences to transmission users that are responsible for schedule imbalances. Each Transmission Service Provider in the Pacific Northwest administers its own imbalance process as a part of its Open Access Transmission Tariff (OATT). As a result, Transmission Customers that do business across Transmission Service Providers are exposed to disparate imbalance charges. For example, some Transmission Service Providers charge a fixed rate while others use an indexed price. These administrative solutions do not reflect the true cost of imbalance.

As a part of the Regional Proposal, it is envisioned that three or more control areas will voluntarily consolidate their control area operations under Grid West. As a part of this consolidation, it is envisioned that Grid West will administer the RBS on behalf of the consolidating parties. Parties that do not consolidate will continue to implement their respective imbalance procedures. Consequently, Transmission Customers that do business with Grid West Transmission Service

Providers who are not part of CCA will continue to be charged for imbalance per the terms of the non-consolidating TSPs tariff. Imbalance for pre-existing transmission services will continue to be governed by the terms of the tariff or contract under which such service is provided. The Grid West RBS will provide an optimal, bid-based balancing service for the benefit of the CCA, while maintaining security constraints. While this is the primary objective of the service, additional benefits could include:

- Establishing equitable treatment of imbalances
- Promoting increased usage of available transmission in real-time
- Providing improved price signals for the forward markets
- Motivating and informing investment in generation and transmission

4.0 REAL-TIME BALANCING SERVICE

4.1 Overview

Energy imbalance is a part of normal operations. It occurs in control areas continuously. Currently the region does not have a consistent approach to dealing with imbalances. As a result of consolidation, the Grid West CCA will provide a Real-Time Balancing Service to all Transmission Customers in the CCA. Balancing service will be provided for the CCA in order to address/facilitate:

- Offsetting deviations from schedules
- Load/Generation Following
- Congestion Management (Redispatch for Reliability)
- Economic Dispatch (Re-dispatch for Economics)

The goal of the RBS is to match generation with load in a least cost manner, while respecting security constraints. Since participants are required to submit balanced schedules, the imbalance requirement should be relatively small. In other markets with balanced schedule requirements, like ERCOT and CAISO, imbalance energy makes up less than 5% of total energy demand. This percentage is also observed in markets that do not require balanced schedules, but have a DA market that generates balanced schedules.

4.2 *Balanced Schedules*

As a part of the day-ahead scheduling process, participants are required to submit hourly balanced schedules based upon their submitted load forecasts. For example, if Participant A has a load forecast of 100 MW, it must submit a balanced schedule, identifying the resources that will be used to meet its load plus allocated losses. By definition, imbalance does not exist at this point (resource MW = load MW + allocated losses). However, during real-time operations, conditions arise (e.g., actual load differing from forecasted load, loss of generation, etc.) where participants deviate from their schedules, resulting in imbalances. In these instances, Grid West will need to provide imbalance service on behalf of participants within the CCA.

Energy imbalance will be calculated, by participant, as the difference between actual metered values, and either final schedules (this paper will assume a scheduling deadline at 30 minutes prior to the operating hour), or schedules as determined by the RBS or as otherwise changed by Grid West. Energy imbalance charges will be based on the locational imbalance price, as determined by the RBS.

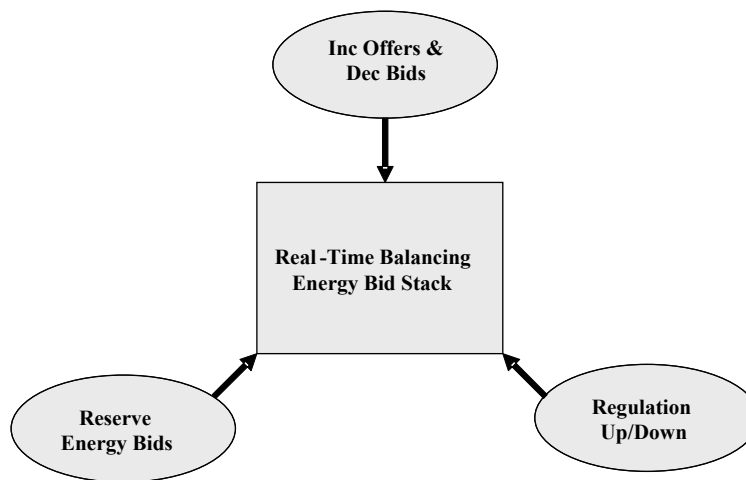
4.3 *Supply of Imbalance Energy*

Resource participation in the RBS is voluntary. Participants can bid into the market to give Grid West options it can use to provide the imbalance service. Grid West will meet its balancing needs by procuring balancing service from the following sources:

- **Inc Offers & Dec Bids.** Participants can submit energy offers and/or bids for real-time energy up until 30 minutes before each operating hour. An INC offer indicates a willingness to increase generation at a specific injection point by a given amount for a given price. In under-generation situations, these offers are primarily used to obtain the lowest cost energy available to the CCA. A DEC bid indicates a willingness to reduce generation at a point of injection by a given amount for a given price. This is equivalent to a bid to buy energy from Grid West for a given price in lieu of generating as originally scheduled. In over-generation situations, these offers are used primarily to get the highest price for energy that is surplus to CCA needs. Dispatchable loads that submit INC offers or DEC bids, indicating their willingness to decrease or increase their load by a given amount for a given price, have an effect that is equivalent to increased generation or decreased generation.

- **Ancillary Services Energy Bids:** Participants whose capacity offers have been selected as a part of the reserve market may also submit a separate offer for energy in case they are called upon in real-time. These resources may make their energy bid conditional.
- **Regulation:** Regulating Reserve is used in conjunction with automatic generation control (AGC) to offset random fluctuations in system balance.

Figure 4.1 RBS Bids and Offers Stack



Participants submitting INC offers and/or DEC bids have the ability to flag their submissions as "Reliability Only". These bids will not be used for economic transactions. Instead they will only be used to resolve imbalance or manage transmission congestion. Participants outside the CCA can also submit bids and offers to provide services. These bids and offers will only be selected if they help meet the requirements of the CCA (i.e., energy imbalance, congestion and economics of the CCA).

Bids and Offers will be in the form of price-quantity pairs describing a curve of up to ten segments, and may be changed for each interval. For example, for a generator with a curve with 4 segments, the price quantity pairs for two intervals may look as follows:

Table 4.1 Bids/Offers Price Quantity Pairs

Hour	Segment	MW	Price
0100	1	10	5
0100	2	20	10
0100	3	30	20
0100	4	40	50
0200	1	10	7
0200	2	20	11
0200	3	30	21
0200	4	40	60

Participants can adjust their bids and/or offers up to 30 minutes prior to the Operating Hour.

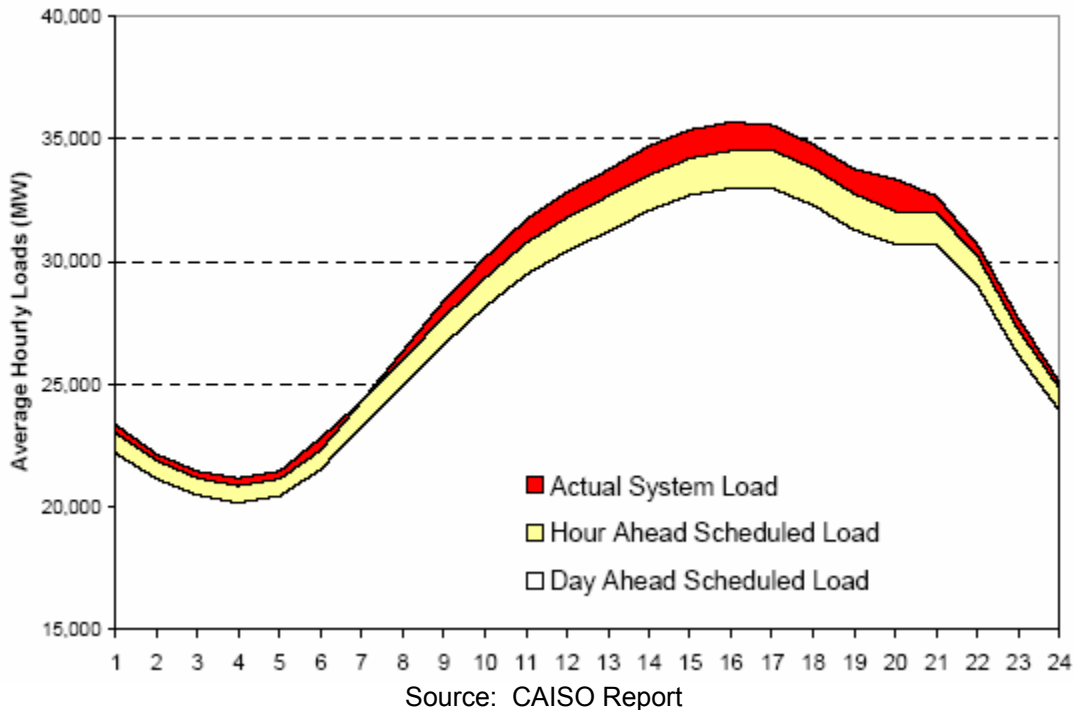
4.4 Imbalance Requirement

Grid West is only concerned with imbalance within the CCA. Control Areas outside the CCA will deal with imbalance as they choose.

Other RTOs/ISOs attempt to minimize the amount of imbalance energy that is required in real-time by ensuring that there is enough scheduled generation to meet forecasted load. This is accomplished by either imposing a balanced schedule requirement or running centralized day-ahead energy market. Since Grid West does not have a DA market, it will impose a balanced schedule requirement similar to CAISO and ERCOT.

The balanced hourly schedule requirement does not address imbalances in real-time. Hourly schedules are by their nature fixed, while load is dynamic through time, often changing dramatically through a given hour, and requiring large generation changes generally referred to as load following. To accommodate some degree of self-provision for load following, Grid West will allow participant to submit “ramped” schedules. These will specify ramp rates, generation ranges, and time intervals such that Grid West will be able to predict the generation changes expected in the CCA. To account for the remaining deviations, Grid West will perform a short-term load forecast to determine the demand for the balancing period. Grid West will compare this forecast with the current real-time system conditions and scheduled generation changes in order to calculate the balancing requirement for the next interval. Given that Grid West is only providing balancing service to meet these deviations (provided that all generation performs as scheduled) balancing energy will be small relative to the total wholesale generation produced for a given dispatch interval.

Figure 4.2 Actual Loads vs. Hourly Load Schedules



4.5 Security Constrained Economic Dispatch (SCED)

Grid West stacks the bids and offers submitted by participants in merit order (lowest to highest for the INCs and highest to lowest for the DEC). Specific rules associated with the stacking of non-spinning, spinning, and regulation reserve conditional energy offers still need to be developed. Grid West then operates a Security Constrained Economic Dispatch (SCED) to bring the CCA into balance. The objective function of SCED is to select bids and offers that maximize Real-Time Balancing Service value for the CCA.

The inputs into the model are:

- Short-term Load Forecast
- Current System Conditions (from State Estimator)
- Constraints (Transmission and Generation)
- INC offers & DEC bids
- Resource Schedules (Operating Plan and Constraints)

The SCED algorithm will resolve any CCA imbalance while maintaining system security. In addition, it will also re-dispatch all resources whose bids can improve economic efficiency. This is similar to real-time balancing markets used by other RTOs/ISOs. The result is a least-cost dispatch solution consisting of locational imbalance prices, generation basepoints, and adjusted Net Scheduled Interchanges (NSIs). The locational prices can vary from one interval to the next. The prices reflect the value of imbalance energy for a specific period of time and location. The solution is “security constrained” in that it takes into consideration security limits and contingencies.

The execution frequency for the SCED process has been deferred to future design phases.

5.0 DISPATCH INSTRUCTIONS

After the balancing service required for a time interval is determined, Grid West must communicate its results (dispatch instructions) to the participants. This is referred to as central dispatch. Under normal operating conditions, only resources (generation and load) that participate in the RBS (those who submitted bids and offers) will receive dispatch instructions. Resources that do not participate in this service will be considered “non-dispatchable” for balancing purposes.

Dispatch instructions will be in the form of generation basepoints. Basepoints are total specific MW values (i.e. 100 MW) for generation output - as opposed to incremental amounts (i.e., up 10 MW, down 20 MW). Basepoints will be sent to the generators through the consolidating transmission owners control centers five minutes prior to the real-time operating period (T-5). Control centers will either ramp the units or pass the Basepoints to the Generator Operators, so that they achieve the target MW output at time T. Grid West will not directly control generating units. The respective control centers and Generator Operators will be responsible for implementing these instructions. This approach is similar to some of the existing RTOs and ISOs where the control centers of the participating utilities are maintained. It, also eliminates concern regarding the operation of Federal resources by non-federal entities. Finally, this approach leverages existing infrastructure and minimizes incremental costs. Where there are multiple generators at a single node, they may be offered as a single unit and will be dispatched as described above.

For RBS participants not within the CCA, the incremental (or decremental) energy that results from this dispatch will be implemented as a dynamic schedule.

6.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of Grid West and participants within and outside the CCA are described in the table below.

Table 6.1 RBS Roles and Responsibilities

Time	Grid West	Participant within the CCA	Participant Outside the CCA
OH-30		<ul style="list-style-type: none"> Submit Final Schedules Submit INC offers or DEC bids (voluntary unless there are insufficient bids and offers to meet needs) 	<ul style="list-style-type: none"> Submit INC offers or DEC bids (voluntary)
T-5	<ul style="list-style-type: none"> Calculate Load Forecast Perform SCED Send NSI signals Issue Dispatch Instructions 		
T	<ul style="list-style-type: none"> Monitor ACE for CCA 	<ul style="list-style-type: none"> Ramp units 	<ul style="list-style-type: none"> Ramp units
T + 5	<ul style="list-style-type: none"> Monitor performance 	<ul style="list-style-type: none"> 	<ul style="list-style-type: none">
T + 60	<ul style="list-style-type: none"> Post Results 	<ul style="list-style-type: none"> Download Results 	<ul style="list-style-type: none"> Download Results

7.0 MARKET BENCHMARKS

All RTOs/ISOs have a functioning real-time balancing/energy market. In addition, several have day-ahead energy markets in order to balance their schedules before entering into real-time operation. The proposed balancing service is closest to the real-time energy market used by ERCOT. The primary difference is that ERCOT currently uses a less granular pricing model (zonal) for both generation and load.

Table 7.1 Market Benchmarks

Attribute	PJM	ERCOT	MISO
Zonal/Nodal	<ul style="list-style-type: none"> Nodal 	<ul style="list-style-type: none"> Zonal 	<ul style="list-style-type: none"> Nodal
Bidding Mechanism	<ul style="list-style-type: none"> Offer Curve 	<ul style="list-style-type: none"> Inc/Dec 	<ul style="list-style-type: none"> Offer Curve
Bidding Granularity	<ul style="list-style-type: none"> Daily 	<ul style="list-style-type: none"> 15 min 	<ul style="list-style-type: none"> Hourly

Pricing	• LMP	• LMP (zonal)	• LMP
Dispatch Granularity	• Unit Specific	• Portfolio	• Unit Specific
Dispatch Frequency	• 5 min	• 15 min	• 5 min

8.0 TECHNOLOGY SOLUTIONS

The Real-Time Balancing Service requires the following applications/systems:

- Scheduling/Bidding Application
- Real-Time Monitoring Tools (State Estimator, Power Flow)
- Load Forecasting Application
- Balancing Market and Dispatch Function (SCED, etc.)
- Existing CCA participant infrastructure

9.0 COST DRIVERS

The primary cost drivers associated with the Real-Time Balancing Service & Dispatch include:

- Bidding granularity
- Number of locations
- Market clearing frequency
- Dispatch granularity

10.0 DESIGN ISSUES FOR CONSIDERATION IN NEXT DEVELOPMENT LAYER

The following design issues are open for further consideration:

- *Dispatch Frequency* – What should the dispatch periodicity? 5, 10, 15 minutes?
- *Intra-hour generation ramps* – To accommodate some degree of self-provision for large generation ramps, it is expected that Grid West will allow participant to submit “ramped” schedules. These will specify ramp rates, generation ranges, and time intervals such that Grid West will be able to predict the generation changes expected in the CCA. (See Section 4.4)

- *Limited must-offer*: The real-time balancing market is voluntary. However, since Grid West does not own any resources it must have an adequate supply of bids to maintain reliable operations. Since the real-time balancing service has been created for the benefit of the CCA, should consolidating parties have an obligation to make offers to the balancing service if sufficient offers have not been submitted by a given time? The current consensus in the TSLG is to have Grid West make an adequacy assessment when running the day-ahead reserve market, allowing it to invoke the limited must-offer obligation on an as needed basis.
- *Load Frequency Response* – How is regulation taken into consideration in the Bid Stack? How will Grid West deploy it? Should this be included in the A/S deployment paper?
- *Bid Cap* – Since demand is generally not price-sensitive, scarcity conditions can generate high prices. Grid West will have to determine the appropriate bid cap, in any, to set.
- *Congestion Outside CCA* – How will congestion be managed outside of the CCA?

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1.0 EXECUTIVE SUMMARY

As the Transmission Authority for the Grid West Managed Transmission System (GWMT), Grid West will be responsible for developing and implementing emergency procedures. Grid West will monitor relevant system conditions, will identify and declare emergency conditions as necessary, and will work with Transmission Owners, Balancing Authorities, Load-serving Entities and Generation Owners within the GWMT to implement emergency procedures. Grid West will also work with the Pacific Northwest Security Coordinator (PNSC) and the Northwest Power Pool (NWPP) on the implementation of the NWPP Energy Emergency Plan and to coordinate receiving and/or providing assistance during emergency conditions.¹

Highlights of this paper include:

- Grid West will be responsible for the development and implementation of emergency procedures for the GWMT.
- Grid West's emergency operations responsibilities are defined within the framework of the responsibilities identified in NERC Reliability Standards.

2.0 PURPOSE

This paper describes the emergency operations responsibilities that Grid West will perform for the GWMT. The paper uses NERC Reliability Standards as a framework for identifying the relevant emergency operations responsibilities.

3.0 BACKGROUND

3.1 Emergency Conditions

For the purposes of this paper, an emergency system condition is described as follows:

- An abnormal system condition that requires manual or automatic action to prevent or limit loss of transmission facilities, generation resources, or load; and that impacts or could adversely affect the reliability of the electric system.

¹ Given the differently situated regulatory regime in Canada and British Columbia, in particular, the operating assumption is that the Grid West market design will be mirrored in British Columbia, to the extent possible within that regulatory regime. Details regarding the market design in British Columbia are anticipated to be completed as part of detailed design phase of this effort.

- A condition where an LSE is, or expects to be, unable to provide its customer's energy requirements, and has been unsuccessful in locating other systems from which to purchase, or cannot schedule resources due to system limitations, e.g., AFC or transmission loading relief.

3.2 Operating Limits

Operating limits used for the identifying and declaring of emergency conditions are defined as follows:

- System Operating Limit (SOL). The value (such as MW, MVar, Amperes, Frequency or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. System Operating Limits are based upon certain operating criteria. These include, but are not limited to
 - Facility Ratings
 - Transient Stability Ratings
 - Voltage Stability Ratings
 - System Voltage Limits
- Interconnection Reliability Operating Limit (IROL). The value (such as MW, MVar, Amperes, Frequency or Volts) derived from, or a subset of, the System Operating Limits, which if exceeded, could expose a widespread area of the Bulk Electric System to instability, uncontrolled separation(s) or cascading outages.

3.3 NERC Reliability Standards

NERC Reliability Standards describe the responsibilities of an Operating Authority during emergency operations. The policy describes an Operating Authority as an entity that:

- Has ultimate accountability for a defined portion of the bulk electric system to meet one or more of three reliability objectives – generation/demand balance, transmission reliability, and/or emergency preparedness, and
- Is accountable to NERC and its Regional Reliability Councils for complying with NERC and Regional Policies, and

- Has the authority to control or direct the operation of generating resources, transmission facilities, or loads to meet these policies.

As the Transmission Authority for the GWMT, Grid West will perform these responsibilities for the GWMT. Therefore, Grid West is the Operating Authority for the GWMT within the context of this policy.

3.4 NWPP Energy Emergency Plan

The NWPP Energy Emergency Plan has been put in place by control areas in the NWPP area to increase the area's ability to avoid a power emergency or longer-term adequacy problem by promoting area coordination and communications. The plan is aimed at promoting actions in advance to avoid potential short-term emergencies and longer-term energy adequacy problems in the NWPP area. These actions are targeted to alleviate the need for the Interconnection Reliability Coordinator to declare a NERC Energy Emergency Alert 1, 2 or 3 as defined in NERC Policy 9, Appendix 9B. The plan is designed to be invoked when the area has a high degree of confidence that a future short-term power emergency or a long-term energy adequacy problem would adversely affect reliability within the NWPP.

4.0 GRID WEST'S EMERGENCY OPERATIONS RESPONSIBILITIES

Grid West will serve as the Transmission Authority for the entire GWMT. Transmission Owners and Generation Owners will have operational responsibilities for their facilities as directed by Grid West or per standing order.

As the Transmission Authority for the GWMT, Grid West will have the responsibility and authority to direct and coordinate the operation of transmission facilities within the GWMT to maintain the reliability of the bulk electric system. A key component of these responsibilities is to develop and implement emergency procedures.

The table below summarizes Grid West's emergency operations responsibilities within the framework of the responsibilities identified in NERC Reliability Standards (see Section 3.3).

Table 4.1 Emergency Operations Responsibilities

Responsibility	Description	Grid West's Responsibility
Operating within limits	The Operating Authority shall operate within system operating limits (SOLs) and interconnection	GW will perform for the GWMT.

Emergency Operations

	reliability operating limits (IROLs).	
Operating Authority and responsibility	<p>The Operating Authority shall have the responsibility and clear decision-making authority to take whatever actions are needed to ensure the reliability of its Operating Authority Area and shall exercise specific authority to alleviate operating emergencies.</p> <p>The Operating Authority shall take immediate actions to alleviate operating emergencies including curtailing transmission service or energy schedules, operating equipment (e.g., generators, phase shifters, breakers), shedding firm load)</p> <p>The Operating Authority shall comply with the Interconnection Reliability Coordinator directives unless such actions would violate safety, equipment or regulatory or statutory requirements. Under these circumstances the Operating Authority must immediately inform the Interconnection Reliability Coordinator of the inability to perform the directive so that it can implement alternate remedial actions.</p>	GW will perform for the GWMT.
Unknown operating states	If the Operating Authority enters an unknown operating state (i.e. any state for which valid operating limits have not been determined), it will be considered to be an	GW will perform for the GWMT.

Emergency Operations

	emergency and shall restore operations to respectable, proven reliable power system limits within 30 minutes.	
Information sharing	To facilitate emergency assistance, the Operating Authority shall inform other potentially affected Operating Authorities and its Interconnection Reliability Coordinator of real-time or anticipated emergency conditions, and take actions to avoid when possible, or mitigate the emergency.	GW will perform for the GWMT.
Rendering assistance	The Operating Authority shall render all available emergency assistance requested, provided that the requesting Operating Authority has implemented its comparable emergency procedures, unless such actions would violate safety, equipment or regulatory or statutory requirements	GW will perform for the GWMT.
Keeping facilities in service	<p>The Operating Authority shall not remove bulk electric system facilities from service if removing those facilities would burden neighboring Operating Authorities unless:</p> <p>The Operating Authority first notifies the adjacent Operating Authorities and coordinates the impact resulting from the removal of the bulk electric system facility or,</p> <p>When time does not permit such notification and coordination, or when immediate action is required</p>	GW will perform for the GWMT.

Emergency Operations

	to prevent a hazard to the public, lengthy customer service interruption, or damage to facilities, the Operating Authority shall notify adjacent Operating Authorities at the earliest possible time to ensure Operating Authority coordination.	
Remaining interconnected	The Operating Authority shall make every effort to remain connected to the INTERCONNECTION. If the Operating Authority determines that by remaining interconnected, it is in imminent danger of violating System Operating Limits or Interconnected Reliability Operating Limits, the Operating Authority may take such actions as it deems necessary to protect its Operating Authority Area.	GW will perform for the GWMT.
Complying with control performance standards	The Operating Authority shall comply with Control Performance Standards and the Disturbance Control during an emergency.	GW will perform for the CCA.
Coordinating interchange	The Operating Authority shall coordinate interchange schedule changes in accordance with NERC Reliability Standards.	GW will perform for the CCA.
Keeping automatic generation control in service	Each control area shall maintain automatic generation control equipment operational and in service.	GW will perform for the CCA.
Taking immediate action	The Operating Authority shall immediately take action to restore the real and reactive power balance. If the Operating Authority is unable to restore its real and	GW will perform for the GWMT.

	reactive power balance, it shall request emergency assistance. If corrective actions or emergency assistance are not adequate to mitigate the real and reactive power balance, then the Operating Authority shall implement firm load shedding.	
Reducing the effects of power flows	The Operating Authority shall immediately reduce the effects of power flows through other Operating Authority Areas if those flows have been identified as contributing to an operating emergency (e.g., resulting in SOL or IROL violations) in those other Operating Authority Areas.	GW will perform for the GWMT.

Grid West will also work with the PNSC, NWPP and other entities in the Pacific Northwest on the implementation of the NWPP Energy Emergency Plan.

5.0 ROLES AND RESPONSIBILITIES

Grid West will be responsible to develop and implement emergency procedures for the GWMT. Transmission Owners (consolidating or not), LSEs and Generator Owners within the GWMT will be responsible to implement actions requested by Grid West during emergency conditions.

6.0 MARKET BENCHMARKS

All existing RTOs/ISOs in North America are responsible for developing and implementing emergency procedures for their operating authority areas.

7.0 TECHNOLOGY SOLUTIONS

The emergency operations responsibilities that Grid West will perform will require the following applications/systems:

- Data acquisition (SCADA) including telemetry from RTUs and/or ICCP

- Real-Time Calculations
- Alarming
- Reserve Computation
- Automatic Generation Control (AGC)
- Outage Scheduling
- Advance Power System Applications; State Estimator, Contingency Analysis, Power Flow, etc.
- Voice communications between Grid West and member entities' control centers

8.0 ORGANIZATION REQUIREMENTS

The following roles have been identified to support the emergency operations responsibilities that Grid West will perform:

Table 8.1 Organization Requirements

Division	Department	Role
Grid Operations	Real-Time Operations	Shift Supervisor
Grid Operations	Real-Time Operations	Grid Resource Coordinator
Grid Operations	Real-Time Operations	Generation Dispatchers
Grid Operations	Real-Time Operations	Real-Time Schedulers
Grid Operations	Real-Time Operations	Transmission Dispatchers
Grid Operations	Scheduling	Scheduling Manager
Grid Operations	Scheduling	Scheduling Coordinator
Grid Operations	Operations Planning	Manager
Grid Operations	Operations Planning	Outage Coordinator
Grid Operations	Operations Planning	Reliability Assessment
Grid Operations	Operations Planning	Operations Engineer
IT Operations	Application Support	EMS Manager
IT Operations	Application Support	EMS Analyst

9.0 COST DRIVERS

The primary cost drivers for the implementation of these Grid West's emergency operations responsibilities include infrastructure, personnel and system requirements. The system and personnel requirements are summarized in the previous two sections.

10.0 DESIGN ISSUES FOR CONSIDERATION IN NEXT DEVELOPMENT LAYER

None

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